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OVERWINTERING OF *POLISTES FUSCATUS* IN CANADA: USE OF ABANDONED NESTS OF *DOLICHOVESPULA ARENARIA*

David L. Gibo

Abstract.—Over 350 females of the social wasp *P. fuscatus* were found overwintering in southern Ontario in two old *D. arenaria* nests. Most of the wasps were in a damaged nest that was attached to the southern side of a building and fully exposed to the sun. Mid-winter mortality was 2.8% or less. A test nest fitted with thermistors and placed in the original location of nest A showed that although the overwintering wasps can occasionally gain a moderate amount of protection (2.5°C) from low ambient temperatures in the intact nest, there was essentially no protection in a damaged nest. This study presents further evidence that adult *P. fuscatus* can survive nearly complete exposure to the midwinter temperature regime of southern Ontario.

Young queens of the social wasp genus *Polistes* are very opportunistic in their choice of overwintering sites and often appear to require only modest protection from the weather. Various species have been found overwintering in a variety of natural and man-made sites, including cracks and crevices in buildings (Gibo 1972; Snelling 1954; West-Eberhard 1969), under shingles and loose tarpaper (West-Eberhard 1969; Gibo unpublished data), in crevices in rocky bluffs (Rau 1930), under bark (Bohart 1942) and in stumps (Hermann et al. 1974). The wasps were often found in clusters, and several species may be present (Bohart 1942; Hermann et al. 1974; Snelling 1954). Old abandoned *Dolichovespula* nests are also utilized by *Polistes* as hibernation sites. Green et al. (1976) found 39 *P. fuscatus aurifer* queens in a nest in southeastern Washington and Zabriskie (1894) collected two *Dolichovespula* nests from buildings during winter in New York and found approximately 160 overwintering *Polistes* in each.

The occasional discovery of large numbers of *Polistes* in old *Dolichovespula* nests suggests that the wasps may select the nests, when available, in preference to other sites. However, the advantages in utilizing the abandoned nests are not readily apparent. Although these aerial nests are usually inaccessible to some potential predators active during winter, such as shrews and ground dwelling rodents, they are vulnerable to other predators such as squirrels, raccoons and birds. Furthermore, the old nests would be expected to offer little protection from low winter temperatures. The insulating properties of *Dolichovespula* nests are known to be relatively modest, and nest temperatures significantly higher than ambient temperatures are

only achieved through large energy expenditures by a population of active adult wasps (Gibo et al. 1974a, 1974b, 1976). An abandoned nest occupied by inactive *Polistes* should, with some lag, simply track the air temperature. The extent of the lag depends upon the effectiveness of the insulation, the rate of change in the air temperature, and the weather (particularly wind velocity). When air temperatures drop rapidly and then rebound the insulating properties of the nest material could, under favorable conditions (primarily little or no wind), have a moderating effect on the nest temperature. Of course, this moderating effect will also apply during brief periods of high ambient temperatures. A slightly more moderate temperature regime and a reduced amplitude in the daily temperature fluctuations, could, on occasion, be important for *P. fuscatus* survival. However, the actual thermal environment of old *Dolichovespula* nests during winter is unknown. The purpose of this note is to (1) report the use of old *Dolichovespula* nests by *P. fuscatus* in Canada, (2) report the midwinter survival rate of these wasps, and (3) examine the effectiveness of an old *Dolichovespula* nest in moderating the winter temperature regime.

Two old nests of *D. arenaria* were collected in midwinter in southern Ontario and examined for *P. fuscatus*. Nest A was collected on January 2, 1979. This nest had been partially destroyed by winter storms in 1978 and was missing part of its envelopes, partially exposing the combs on one side. It contained 354 *P. fuscatus*. Nest B was collected on January 11, 1979 and contained only 7 *P. fuscatus*. Midwinter mortality was low for both groups: 2.8% (10 wasps) for nest A and 0% for nest B. All of the overwintering *P. fuscatus* were females and, presumably, young queens. (West-Eberhard (1969) reported that all overwintering and overwintered *P. fuscatus* females that she examined (N = 28) during her studies in Michigan were found to be inseminated, and thus were potential queens.) In nest A a few wasps were found overwintering between envelope layers but most were either clustered on the combs or wedged head first into the cells. This latter posture is often observed when *P. fuscatus* are collected from their own nests in the fall. The wasps in nest B were clustered between the combs. Approximately 20 overwintering Diptera (Tachinidae) were also found in nest A.

The sites of the two old nests were similar. Both were attached to the overhang of the roof of a four-storey concrete building of the Erindale College campus of the University of Toronto. The nests were attached to the outer edge of the overhang, approximately 2 meters from the walls and 20 meters above the ground. Nest A was located on the southern side of the building and nest B was on the northern side. The difference in occupancy of the nests may have been due to the late season activity of the wasps. Every sunny day during the late summer and fall large numbers of *P. fuscatus* males and females were observed to gather on south facing walls of the building in the afternoon. The male wasps attempted to mate with pass-

ing females while the females spent much of their time investigating cracks and crevices in the masonry, apparently searching for overwintering sites. During the same period only an occasional wasp was observed on the shaded north facing walls.

In order to investigate the thermal environment of an old *D. arenaria* nest an intact nest that had been attached to a branch was obtained in the fall of 1979 and fitted with 2 thermistor probes. The probes were placed in the sections of the nest occupied by the overwintering *P. fuscatus* in nest A: between the central combs and in space between the roof of the nest and the top comb. Two additional probes were placed near the nest (5 cm and 1 m) to monitor air temperatures. The entire apparatus was clamped to a pole and, in early January of 1980, was securely attached to the overhang of the roof at the original location of nest A. Data were collected for 10 days. Records of the ambient temperature, nest temperatures and wind velocity were recorded in the early morning, midday, and late afternoon or whenever the ambient temperature was unusually high or low.

The results showed that an intact nest did provide some protection. During the first three days the ambient temperature ranged between −8° and +1°C and the nest temperature between −7.5° and +3°C. When there was little wind (velocity < 2 km/hr) and the ambient temperature was changing rapidly, nest temperatures 2.5°C warmer than the ambient temperature were recorded. These differences occurred during the late afternoon and in the midmorning. When the nest was shaded and the ambient temperature was stable or changing slowly, and when wind velocities were approximately 5 km/hr or greater, nest temperatures were equivalent to the air temperature. However, on clear days exposure to the sun could warm the interior of the nest by approximately +2°. The space between the top comb and the roof of the nest proved to be the most insulated area (i.e., experienced the least change).

After the third day of observations a winter storm removed part of the nest envelopes and partially exposed the combs on one side. The damaged test nest now was in approximately the same condition as nest A when it was occupied by overwintering *P. fuscatus* in January of 1979. As would be expected, the thermal regime of the test nest changed. During the next six days the weather was unsettled and measurements were made under a variety of combinations of wind, cloud cover, and temperature. The ambient temperature ranged between −9.5°C to +2°C, and the nest temperature ranged from −9°C to +7°C. In cloudy periods and at night the nest temperature was always within 0.5°C of the ambient temperature. During the midday when the nest was exposed to full sun it apparently trapped heat, and nest temperatures 5°C higher than the ambient were recorded, even on days when the wind velocity was approximately 15 km/hr.

The nest temperature records indicate that under certain weather conditions an intact *D. arenaria* nest can moderate the ambient temperatures by 2.5°C. This difference may occasionally be significant for *P. fuscatus* survival, particularly when the ambient temperature drops a few degrees below lethal levels for a relatively short period (e.g., before dawn). Although many overwintering *P. fuscatus* are very tolerant of low temperatures, and can survive at least 48 hours at −20°C, they are killed by exposure to 48 hours at −25°C (Gibo 1972, 1976). Temperatures approaching or falling within the lethal range usually occur in southern Ontario each year (Gibo 1972, 1976). Since nightly lows of −17°C had already been recorded at the College prior to the time the wasps in nests A and B were collected in January of 1979, the wasps in nest A had probably experienced these temperatures with little or no moderation.

A reduction of the amplitude of the daily temperature fluctuations only occurred within the intact nest and was restricted to overcast days with little or no wind. On sunny days the test nest had approximately the same or a greater daily temperature fluctuation than the ambient temperature. Exposure to the sun caused even greater fluctuations when the test nest was damaged. Because survival of *P. fuscatus* was high in a damaged nest exposed to the sun, the amplitude of these fluctuations does not appear very important to the wasps. This assertion is supported by other studies that show that overwintering *P. fuscatus* are capable of withstanding frequent cycles of freezing and thawing (Gibo et al. 1976).

In summary, a relatively modest moderation of the winter thermal regime can be obtained by *Polistes* that overwinter in old *D. arenaria* nests. This moderation occurs under specific conditions: an undamaged nest, little or no wind, no exposure to sun, and a rapidly changing ambient temperature. When any of these conditions are not met the nest temperature equals, or in some cases exceeds the ambient temperatures. Since the lowest temperatures usually occur at night, and often persist for several hours, little or no thermal moderation should be experienced by *P. fuscatus* overwintering in old *D. arenaria* nests during these critical periods. Possibly the abandoned nests offer their advantages to overwintering wasps. In addition to shelter from rain, snow and ice storms, the nests provide partial protection from the drying effects of the wind. The temperature data indicated that even damaged nests can provide this protection. Humidity is another consideration. When ambient temperatures are above 0°C, nests which have been recently soaked by rain would maintain high humidities. Whether this effect would persist at temperatures below 0°C remains to be determined. In any case, the study offers further evidence that overwintering *P. fuscatus* are sufficiently cold hardy to survive nearly complete exposure to the midwinter temperature regime of southern Ontario.

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Department of Zoology, Erindale College, University of Toronto, Mississauga, Ontario L5L 1C6, Canada

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